IFPS Science Steering Team (ISST) and other related activities

IFPS Methodology Workshop

NWSTC – Kansas City

10 February 2004

Andy Patrick

NOAA/National Weather Service

Corpus Christi, TX

Outline

- WR SOO/DOH White Paper and follow-on Implementation Plan (Background and Requirements)
- ISST history, accomplishments, and activities
- ISST Current Issues
  - Downscaling efforts (short term and long term)
  - Verification
  - Analysis of Record
- ISST Roadmap

WR SOO/DOH IFPS White Paper
Background

- May 2002 WR SOO/DOH Workshop
  - Concerns raised on the design and implementation of IFPS
- WR SOO Writing Team formed and tasked with authoring WR SOO/DOH IFPS White Paper
  - To represent all WR SOOs/DOHs
  - Gain WR RD and MIC support
  - Eventual endorsement and support of all NWS Regions

WR SOO/DOH IFPS Writing Team

- Brad Colman (SOO, WFO Seattle)
- Mark Jackson (SOO, WFO Salt Lake City)
- *Warren Blier (SOO, WFO Monterey)
- **David Bright (SOO, WFO Tucson)
- Ron Miller (SOO, WFO Spokane)
- Jon Mittelstadt (SOO, WFO Pendleton)
- Mike Staudenmaier (SOO, WFO Flagstaff)

*Contributed to WR SOO/DOH Workshop Report

**Now at SPC; Contributed to WR SOO/DOH IFPS White Paper

A New Forecast Era

- IFPS/GFE is aggressive and revamps much of the way the field does its business
- It has the potential to deliver an unprecedented spectrum of forecasting services
- Gridded forecasting is new and presents many challenges: seen and unforeseen
- The process has been ambitious

WR SOO/DOH IFPS Whitepaper
Primary Issues of IFPS

- Only degraded model data available in GFE
  - Both horizontal and vertical
  - Forecasters spending unnecessary amount of time compensating for this deficiency
  - Prevents full benefit of EMC models
- Time taken from serving other mission critical responsibilities
- No verification system to assess skill and direct efforts

White Paper Assumptions

- Digital forecasting is the right thing to do.
  - Strive to remain on current schedule, but remain realistic
  - React quickly to meet needs and eliminate deficiencies
- Success of IFPS requires exploring, developing, and implementing new methods and technologies.
- Must ensure efficient use of human capital throughout all services.

WR SOO/DOH IFPS White Paper
Core Recommendations

- Develop a National real-time, gridded verification system
- Provide full-resolution NCEP model grids
- Objectively produce bias-corrected model grids for WFO use
- Implement methods to objectively downscale forecast grids
- Incorporate climatology grids into the GFE process
- Deliver short and medium-range ensemble grids
- Modify the GFE software to ingest real-time data
- Optimize ways to tap forecaster expertise

Follow-On Efforts to Address Initial Recommendations

- White paper was focus of May 2003 WR SOO/DOH Workshop
  - Focus groups tasked to identify requirements and possible approaches for each of the WP recommendations, then present to participants
  - Groups composed of SOOs/DOHs and subject matter experts
    - MDL, FSL, universities, and NCAR represented
    - OS&T and program leaders attended
    - Members of the newly-formed IFPS Science Steering Team attended
  - First draft distributed for review/comment to all NWS SOOs/DOHs
  - Final report on workshop results completed by writing team and distributed to all SOOs/DOHs, Regions, and NWSH on 22 Aug ’03

Outline of WR SOO/DOH Workshop Report

"SOO/DOH IFPS White Paper Implementation: Requirements and Approaches"

Eight White Paper Recommendations Combined into Common Issues

- Overarching Requirements
- Verification
- AWIPS and NCEP Data and Model Issues
- Climatology and GFE Enhancements
- Statistical Post-Processing and Downscaling in IFPS
- Probabilistic Information and forecasts in NDFD

Overarching Requirements
Background

- Issues and requirements that are either of such importance, or integral across each of the topics, that they deserve special recognition
- Far-reaching across many programs
  - Requires focused effort and use of additional resources
- Touch on fundamental research questions and customer and partner requirements

Overarching Requirement #1

- Real-time mesoscale analysis of all forecast grids
  - "Analysis of Record"
  - Grid spacing must match highest-resolution forecasts
  - Will have to mature from early prototype 2-D analyses of primary fields
  - Impact of model used for first guess must be accounted for and minimized
  - Analyses to be used for gridded verification and generation of climatology grids
  - Observation system must be supported

Overarching Requirement #2

- Must understand and convey difference between point and grid-box average forecasts
  - Difference between manual CCF and grid-based CCF
    - Special forecaster attention available for manual CCF
      - Very small set of forecast points
      - Forecasters trained on micro-scale characteristics of point observations
      - Forecasts valid for single point
    - Establish new point verification baseline
      - Forecasters are now responsible for all grid points
      - Micro-scale characteristics can no longer be represented
  - A grid-box forecast must be presented as an average for that box
    - Multiple observations within a single grid box
      - If treated to represent point observations, each would result in different verification scores for a single grid box value
    - Many boxes without observations
  - Must be communicated to users

Overarching Requirement #3

- Must incorporate probabilistic information into forecast suite and guidance.
  - Valuable ensemble data are under utilized
  - Provides additional products, e.g, exceedence probabilities
  - Allows partners/customers to make cost/benefit decisions
  - Many situations not suited for deterministic forecast
    - Extended-period winds for tropical cyclones
    - Medium-range forecasts of temperature and precipitation
  - Further supported by NWS Vision 2005, and AMS statement on “Enhancing Weather Information with Probability Forecasts”

Overarching Requirements #4/5

- Renewed emphasis on, and resources for, training
  - Forecasters, partners and user groups
  - Use of NWP in IFPS
  - Interpreting forecast fields
  - Understanding probabilistic information
- Employ team model demonstrated at 2003 WR SOO/DOH Workshop
  - Power of bringing field experts, developers, and managers together – those vested in system and involved in decision making process
  - External experts and users as peer reviewers

Verification
Background

- Need to know accuracy of models used to populate grids
- Need to know impact of forecaster edits
- Feedback important in evaluating overall system performance
- Needed to determine future program direction and design

Verification
Requirements

- Must be integral part of digital forecast system.
  - Operation directed by working team supported by NWS senior management
- Include gridded- and point-based elements.
  - Users can view both – need to know performance in each
- Point system should be able to include any observations available to an office CWA.

Verification
Requirements (continued)

- Critically dependent on "Analysis of Record"
- Flexible in its design
  - Consistent system across all agency levels (WFO to NWSH)
  - Able to be interrogated in multiple ways
  - Immediate feedback in real time
  - Point system flexible for local tailoring
    - Score user-defined zones

Model Data Delivery
Background

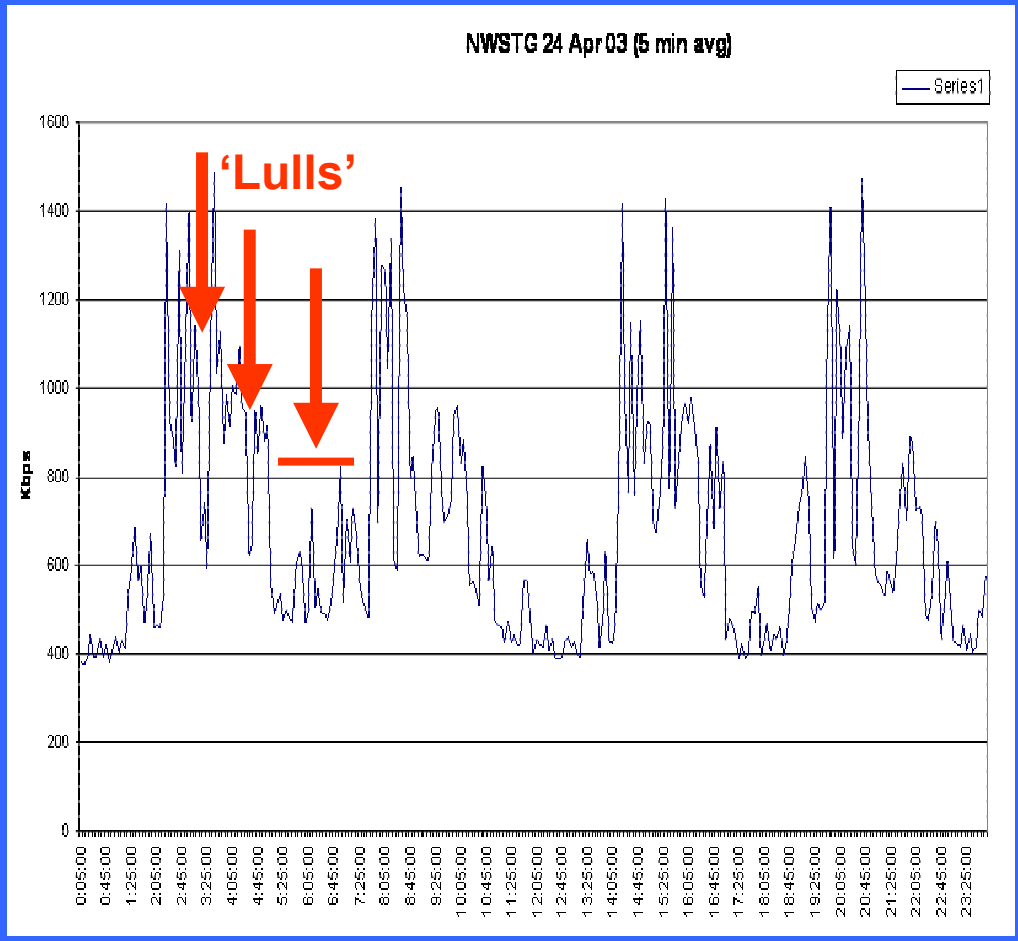
- Model data have always been delivered to field at degraded resolution
  - Was acceptable in a text-based world
    - Prevented communicating high-resolution mesoscale detail to customers
- SmartInit and SmartTools used to add detail back to degraded model data
  - Poor use of resources (human, computer, etc.)
  - Many are crude substitutes for the real thing

Model Data Delivery
Requirements

- Forecasters now require model data at their highest resolutions
  - Horizontal, vertical, and temporal
    - In particular, boundary layer for SmartInit routines
- High resolution data are needed in the medium range (Days 3-7) as well as the short range.
- A new methodology is needed to determine field office requirements and methods to meet these requirements.
  - Ensure new EMC model output and products are quickly available to the field after their conception

Efficient Use of The "Fire Hose"

- Use SBN 'lulls' to transmit additional high resolution NCEP model data to the NWS field offices.



Climatology Grids in IFPS

- Climatology has always played an important role in the forecast process.
- Accurate high-resolution climate grids of *all* forecast variables are essential.
- Regime-based climatologies that can be generated locally are also essential for success.
  - Make tools available to generate these grids

Climatology Grids in IFPS
Requirements

- National seamless climate grids of all IFPS variables at full IFPS resolution
  - Resolution that matches the analysis and verification grids
  - Similar analysis techniques for all three
  - Uses all available data sources (e.g., satellite, radar, lightning)
- Mean and spread distributions of these climate grids for probabilistic forecasting
- The ability to create regime-based local climatologies using forecaster-edited analysis grids
  - Potential to create better first-guess fields than available with current NWP

Enhancements to the GFE
Background

- GFE is a key tool used in IFPS
  - Simple and complex software applications within it
- Field forecasters have been highly innovative in creating GFE Smart Tools that are shared throughout the nation.
  - Developed out of necessity
- More sophisticated enhancements are needed in the GFE to support the field -- both in current requirements and future challenges.
  - Requires experienced developer involvement

Statistical Post-Processing and Downscaling

- Forecasters presently spending too much time on manual grid-editing.
  - All at the expense of the entire forecast and warning process, and short-term situational awareness
- Grid-editing process would be greatly streamlined if forecasters started with the highest quality possible model-derived grids.
- Statistical post-processing has been shown to improve on raw model guidance.
  - Bias correction
- Provide both highest spatial (native-grid) resolution model output, and gridded statistically post-processed guidance.

Statistical Post-Processing and Downscaling: *Requirements*

- Since highest-resolution models are coarser than the grid resolution used in IFPS, further downscaling techniques are also needed.
  - Native model resolution will likely continue to be coarser than IFPS
  - Must be applied to the full-resolution model output fields
- Objective post-processing needed to remove inherent model bias prior to populating model grids.
- Statistical post-processing (e.g., MOS, neural-net approaches) to improve on raw model guidance is needed.
  - Must be performed on the actual scale of the IFPS grids.

Probabilistic Information
Background

- The *NWS Vision 2005:*
  - Calls for weather, water and climate forecasts in probabilistic terms by 2005.
- Also within AMS statement, "Enhancing Weather Information with Probability Forecasts."
  - Adopted by the AMS Council on 13 January 2002 http://www.ametsoc.org/AMS/policy/enhancingwxprob_final.html
- Steady Progress has been made:
  - Short- and medium-range ensembles
  - Hurricane track and severe weather forecasts
  - Ensemble-based MOS, etc.
- However, IFPS is currently not designed to display, or is capable of manipulating, probabilistic information.

Probabilistic Information
Requirements

- An end-to-end process for the delivery, display and use of probabilistic information.
  - Requires efficient handling of a huge volume of data.
  - Can't overload forecasters nor transmission and storage infrastructure.
- Software Utilities and Tools:
  - Forecasters must interrogate and possibly edit data.
  - Customers will extract data to be tailored to their needs.
- Training for Both Internal and External Users
  - Aggressive outreach effort needed

Connection to IFPS Science Steering Team (ISST)

- Team created after submission of white paper
- Composed of field experts chartered to identify and prioritize ongoing IFPS science issues
  - A formal conduit between field personnel and NWSH
- Initial task was to address issues raised in the white paper
  - Continual coordination between ISST and writing team
- Reports directly to the Office of Science and Technology and the Science and Technology Committee of the Corporate Board.

http://www.nws.noaa.gov/ost/ifps_sst/

Team Members

- Brad Colman (team leader) – WFO Seattle
- Peter Manousos – NCEP/HPC
- Dan Baumgardt – WFO LaCrosse
- Mark Jackson – WFO Salt Lake City
- Steve Keighton – WFO Blacksburg
- Andy Patrick – WFO Corpus Christi
- Eric Stevens – WFO Fairbanks
- Bill Ward – PRHQ
- Kevin Schrab (facilitator) – NWSHQ/OST

ISST Accomplishments and Activities

- Identified an opportunity to fill "transmission gaps" on the SBN and developed a proposal now nearly implemented
  - Eta surface and BL fields
- Working with MDL on their efforts to develop COOP MOS (now in GFE) and gridded MOS
  - Number of MOS sites increased by a factor of 3
- Provided scientific critique and feedback into the 10-506 directive process and NVIWT verification plan design
- Recently met w/ Digital Services CONOPS team
- Investigated and prioritized a spectrum of downscaling possibilities and reported to S&T Committee
- Conceived, developed, and championed the Eta extension

ISST Current Issues

- Downscaling: 8-day Eta-12 Extension over CONUS using GFS boundary conditions.
- NVIWT Verification Plan
- Analysis of Record

Downscaling – Purpose

- Extend the information content of "coarse" model prediction fields to finer scales that reflect the influence of detailed local effects such as terrain and/or land-surface.
- Initialization within GFE, especially at day 8.
- Analysis of Record needed to verify NDFD.

Downscaling – Chronology

- ISST and special request from Jack Hayes to consider downscaling and prioritize ideas.
- Reviewed eight proposals, including several from EMC:
  - 25-year 2-km climo of sensible wx by downscaling 25 year 32-km NARR used as observed basis for MOS/Neural Net development to downscale forecasts to 2 km
  - Local model with nudging
  - Anomaly techniques (Lord & Toth)
- First approach (preferred) has long timeline (2+ yrs)
- Strong desire for something to help forecasters with NDFD in the short term led to idea to downscale GFS guidance using Eta extension to 8 days.

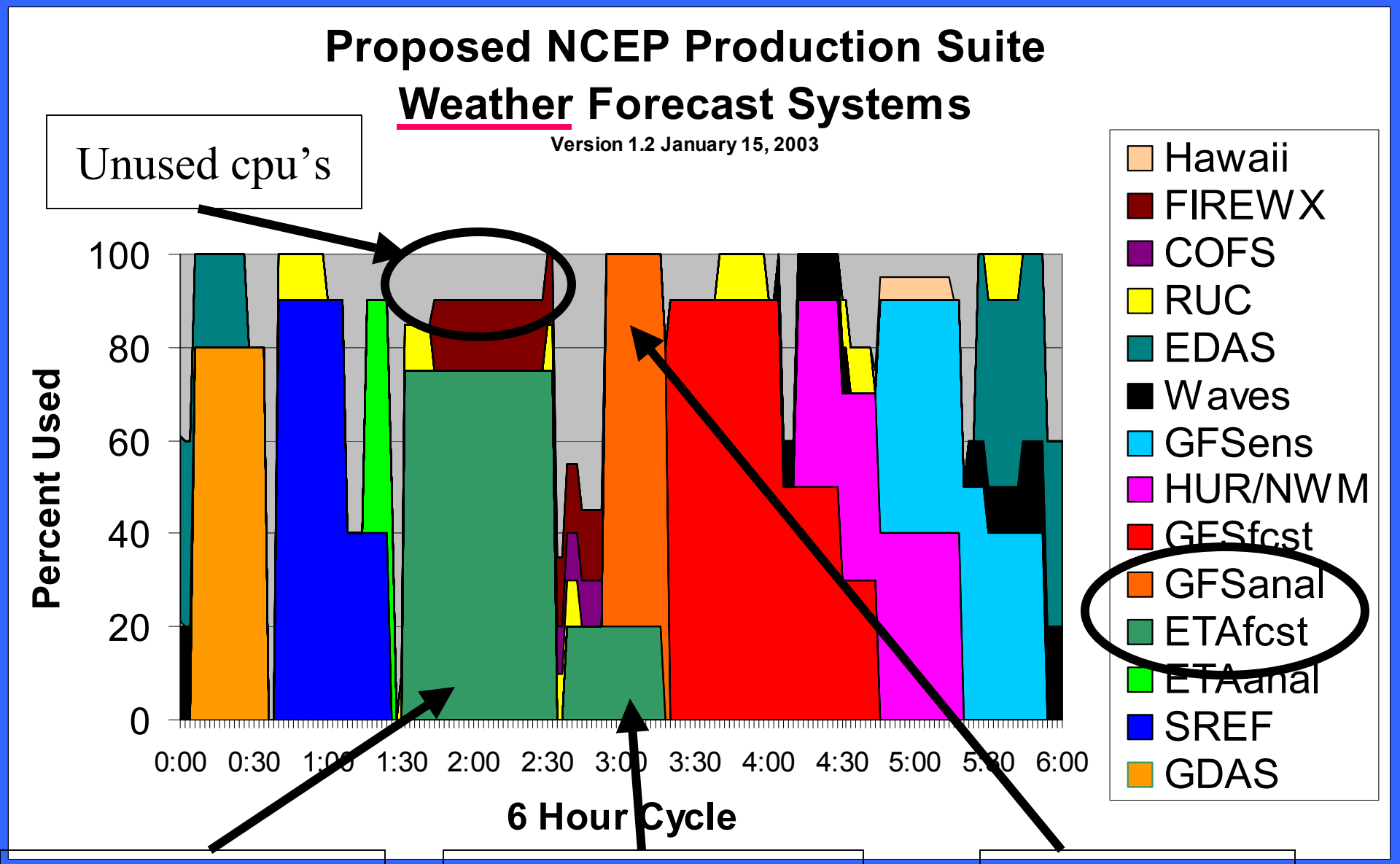
Downscaling – Relevance to NDFD

- Immediate need of the NWS Field is for high res grids to initialize GFE/IFPS/NDFD especially at day 8
- Grids with uniform content out to day 8 at least once per day
- Surface and boundary layer grids to populate GFE / IFPS in anticipation of improving Smart Tools and SmartInit

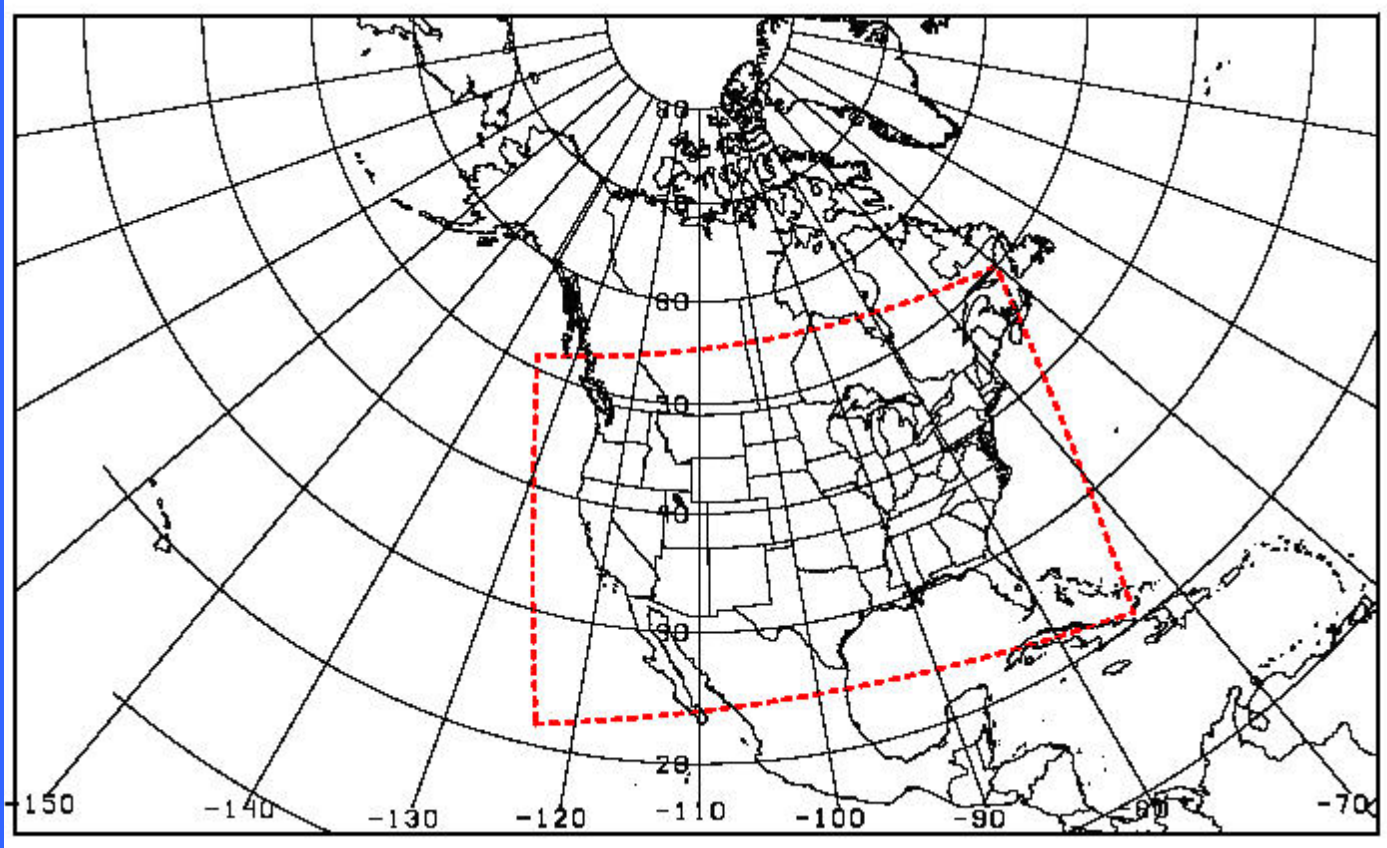
Downscaling – Extension to 8 Days: Feasibility

- Eta extension will produce the desired effect of downscaling the GFS solution because the GFS synoptic scale forecast will dominate the Eta solution in the interior through the effects of the lateral boundary conditions especially for this small a domain and for this long of a prediction
- EMC/CPC have run Eta for extended periods before with no ill effects
  - 10+ days with MRF forecast lateral boundaries
  - 90+ days with Global Reanalysis lateral boundaries

Wx Production Suite Made Up of Four Uniform Cycles per Day



Reduced Eta Domain Allowing 6-day Extension in Same Slot as Current 1-day Extension on Full Domain



Domain could be larger: this is 1/6th for a 6 day extension and we only need to extend 4.5 days so we only need to reduce domain to 2/9th

Downscaling – 8-day Eta Extension

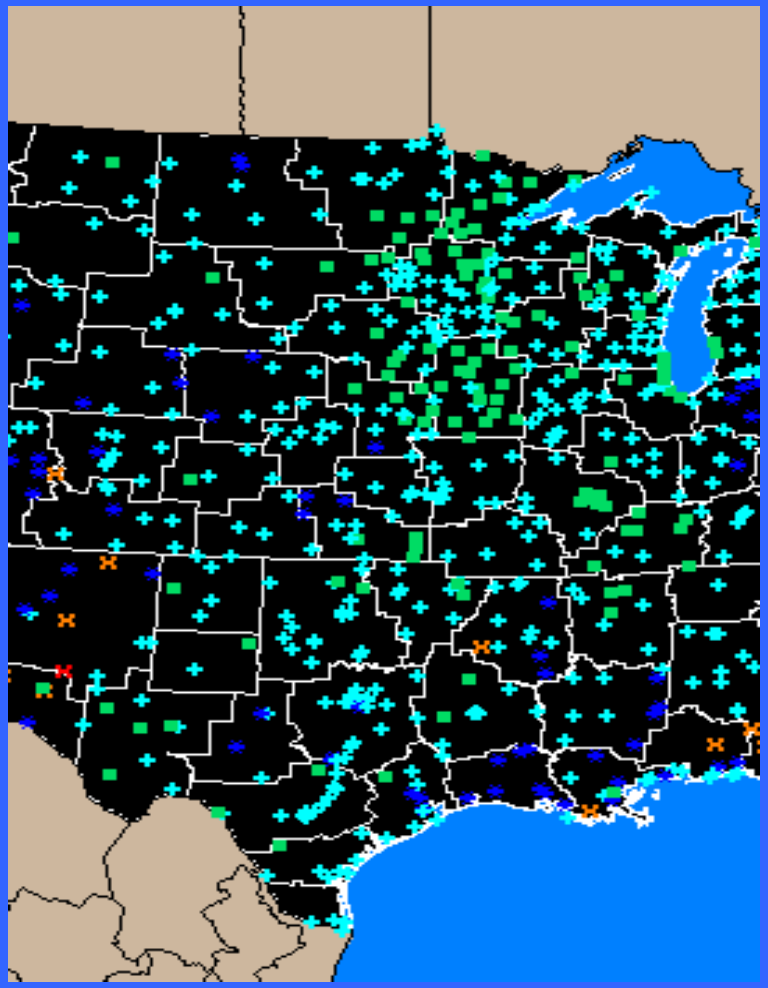
- Background:
  - Designed to bring quick relief to forecasters by giving physically consistent and seamless option for high resolution medium range grids
  - Has received broad support from Regions
- Status and timeline:
  - Tasking complete
  - Change Notification in process (consolidation of Eta run)
  - Test grids available to setup optimal baseline SMARTINIT
  - March: 30-day testing and evaluation period
    - Forecasters at a subset of WFOs to assess impact on operations
    - Better evaluation of internal drift issues (limited set of fields available via a webpage)
    - Test Regional WAN distribution method
    - HPC will perform model diagnostics

Downscaling – 8-day Eta Extension (continued)

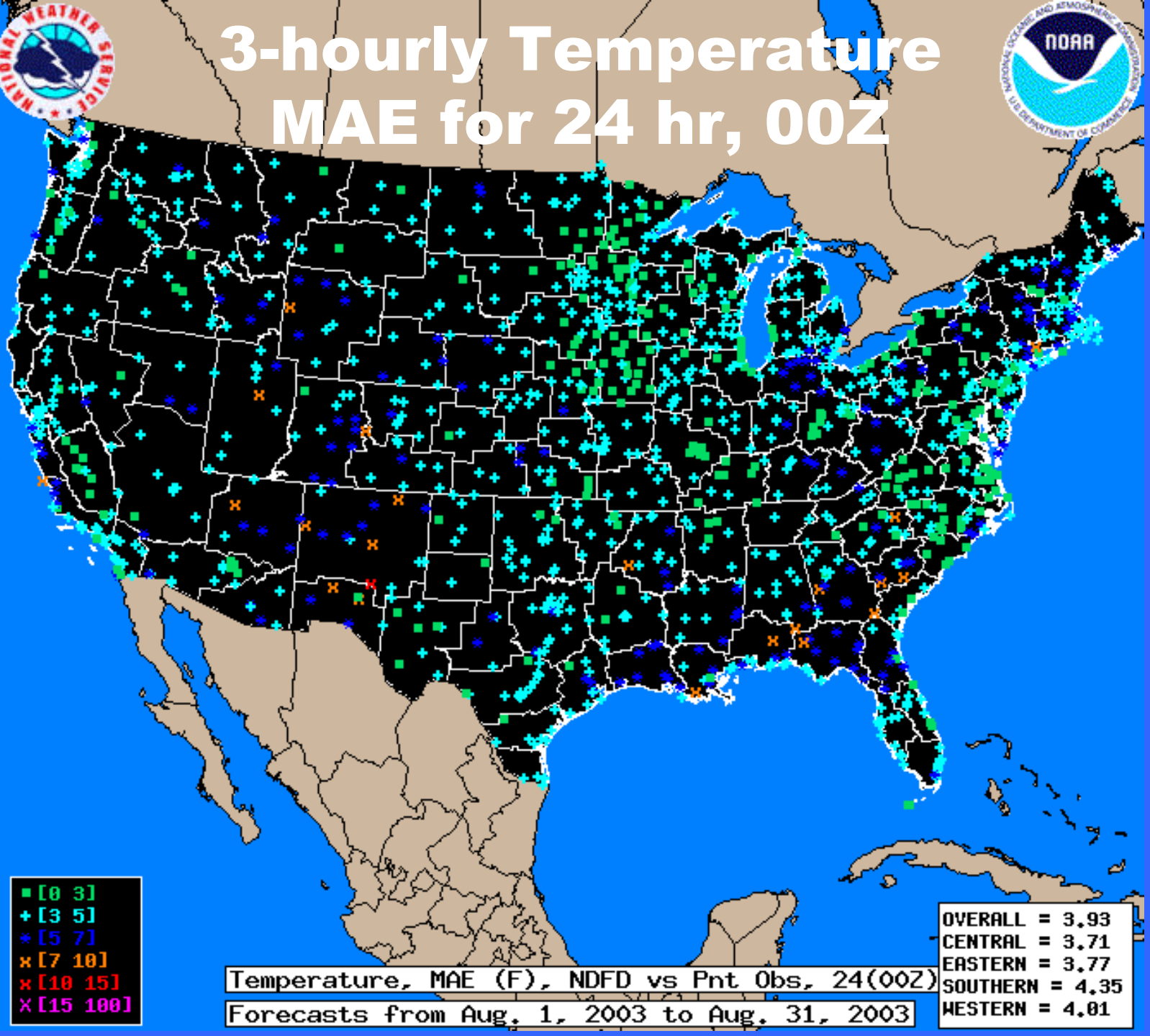
- Mid April: convergence of Eta runs complete and Eta extension running operationally
  - GRIB1 Regional distribution continues
- Late May: DVB-S efforts free up SBN bandwidth
- June: OB3.2 upgrade to AWIPS configuration
- June: Eta extension operational via SBN using GRIB2

ISST Current Issues

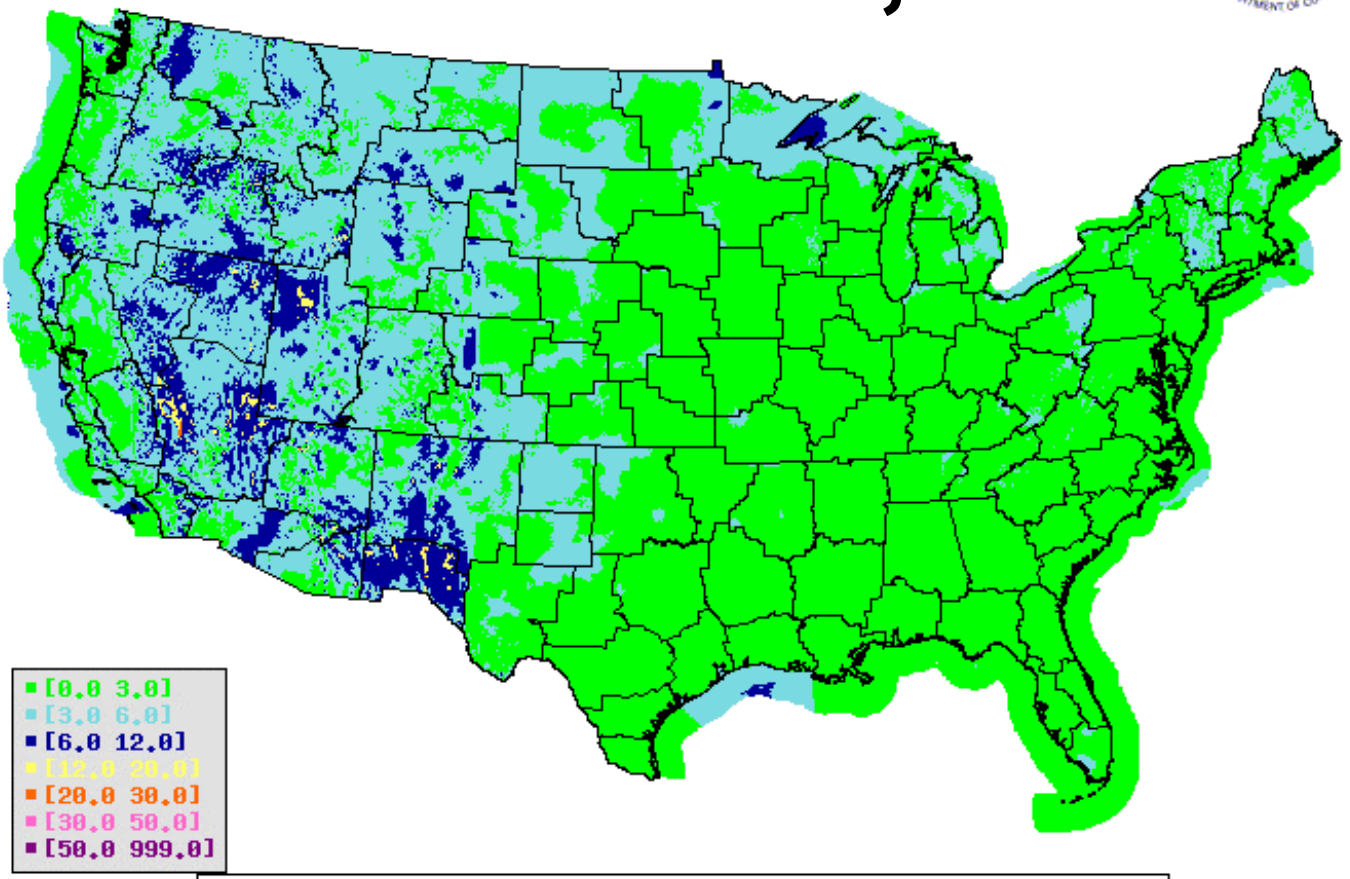
- Verification and Analysis of Record
  - Reviewing Verification Plan
  - Initial discussion on how to get ball rolling on the Analysis of Record



3-hourly Temperature MAE for 24 hr, 00Z



Maximum Temperature MAE for 24 hr, 12Z



VERSUS RUC : 20 km grid

Early results from MDL's gridded verification

Updated Roadmap

- New prioritized list of action topics:
  - Analysis of Record
  - Digital Services forecast process
  - Climatology
  - Downscaling (long-term solutions)
  - Review of 10-506 (preliminary review to OCWWS by late March)
  - Uncertainty and probabilistic information
- Short term actions (next 2-3 months)
  - Verification (prioritize tasks in NVIWT Verification Plan)
  - Input to 10-102 (declaring elements official)

Activities with Ongoing Monitoring

- Grid change management
- GFE enhancements
- SBN data
  - GFS bottleneck on mainframe
- TCM (Tropical Cyclone Message)
- Gridded MOS

ISST and You

- ISST Forum Teleconference
  - Lines available for all Region
  - ISST will discuss latest work and S&T committee briefing
  - Provides a forum for your feedback
- Call/email, me or any ISST member, your IFPS ideas and concerns
- Post-IOC: ‘The year of science’

http://www.nws.noaa.gov/ost/ifps_sst/

Closing Comments

- IFPS presents an extreme, but potentially beneficial shift in forecast operations
- White paper recommendations designed to ensure the scientific integrity of IFPS
- 2003 WR SOO/DOH Workshop
  - Set out to establish specific requirements and approaches to white paper recommendations
- ISST establishes a formal conduit between the field and NWSH
  - System now in place to forward future IFPS science issues from the field for quick and proper resolve